Chapter II

The Economics of Remedies

The aim of this chapter is to challenge the current view of restoration as an adequate remedy for environmental liability. Although the primary goal of tort law from an economic perspective should be optimal deterrence, various issues, including information costs, low probability of detection and polluter's insolvency may hinder its potential of inducing both injurers and victims to adopt optimal care. On the other hand, even if restoration is conducted under perfectly efficient and sustainable conditions, full victim compensation is equally hard to achieve. For this reason, it seems that if remedies for environmental harm are exclusively based on restoration it is highly unlikely that both goals of environmental policies (optimal deterrence and full compensation) can be achieved. Alternatives based on a combination of monetary and non-monetary remedies would be thus needed to enhance the efficiency of liability laws.

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1. Introduction

In the absence of adequate administrative pollution control measures, private actions have been progressively employed to pursue the goals of environmental policies[1], namely, deterrence and compensation (remediation of the damage). Particularly, optimal deterrence can be only achieved where liability laws are designed in a way that tortfeasors and victims receive incentives to adopt optimal levels of care and activity. One important factor in the establishment of optimal levels of care and activity is the assessment of the magnitude of liability and its correspondence to the magnitude of harm.

Scholars of law and economics have been delving for decades into the accuracy of liability and the incentive effects of damages on victims and tortfeasors. Generally speaking, if remedies consist of monetary compensations (damages), judges tend to employ proxies in order to get closer to the unobservable loss (e.g., the price of houses, the price of recreation activities, costs of replacement or costs of production). If, instead, remedies are represented by restoration orders (in-kind restitution), they are deemed to achieve full victim compensation while saving the high costs of the economic valuation (tertiary costs). In other words, it seems that nonmonetary remedies can make the society as well off as before the accident, although their incentive effect on injurers and victims (as well as their potential of achieving restoration in a cost-effective way) has not been fully investigated by law and economics scholars. The analysis below wishes to fill in this gap by comparing the two main remedies for environmental harm (restoration and damages) and trying to identify which remedy (or combination of remedies) for environmental liability can theoretically provide optimal incentives to minimise the social costs of accidents to the environment.

2. Goals of environmental liability

It hardly needs explanation that environmental accidents lead to huge costs for the society and, thus, they require adequate measures to prevent and compensate them. If we look at the existing tools to tackle environmental harm from the perspective of an environmental economist, we can see a general distinction between command-and-control regulations and market-based instruments. They all play a role to control environmental pollution when, due to the high transaction costs, private parties cannot bargain and, so, address market failures[2]. However, the two classes of instruments largely differ. The former (conventional approach) employ rigid regulations to force all firms and individuals to uptake the same share of pollution-control burden irrespective of the costs[3]. They include uniform standards (technology and perform-based standards). The latter aim to induce firms and individuals to undertake pollution control through price signals, such as tradable permits and pollution charges[4].

Private law belongs to this last category as it provides potential polluters with strong incentives to consider the potential environmental damage of their decisions[5]. Its role regarding

[1] Werner Pfenningstorf, 'Environment, Damages, and Compensation', (1979) ABF, 353

[2] *Ibidem.*

[3] R. Stavins 2003.

[4] For an extensive review of environmental market-based instruments, see R. Stavins "Experience with Market-based Policy Instruments" in The Handbook of Environmental Economics, ed. K. Mäler and J. Vincent, 2003.

[5] *Ibidem.*

environmental harm has been much debated in the economic literature[6] as well as in the legal scholarship[7].

Particularly, scholars of law and economics investigated in depth the preventive role of liability. The mechanism of prevention can be summarised as it follows. If a polluting firm knows that it will be *ex post* liable for the damage caused by its polluting activity, it is induced to take *ex ante* optimal care. In other words, through the threat of liability laws firms (should) invest in care up to the point where the marginal cost of abatement is equal to the marginal damage that will be imposed to the society tomorrow[8]. In this way, liability laws pursue deterrence through the internalisation of externalities (economic goal)[9]. The translation of the economic principle of internalizing externalities into the law is represented by the "polluter-pays" principle. Based on this principle, liable parties have to provide victims with adequate compensation in order to make them as well off as before the accident (make the victim *whole*)[10]. This is very easy in case of accidents causing pecuniary losses (see below), but not in case of injuries affecting natural resources void of market value (nonpecuniary losses)[11].

From a purely legal perspective, the emphasis is not so much on prevention but on the compensatory role of tort law (victim compensation), so that victims are brought back to the *status quo ante*.

Scholars of law and economics[12] have largely investigated how liability laws and remedies should be shaped in order to achieve the above-mentioned goals of environmental policies[13]. The debate more specifically revolved around two central questions: whether the law is providing optimal incentives to prevent environmental pollution and whether the law is providing compensation at the lowest cost[14]. This contribution wants to continue along these two research trajectories, but focusing solely on remedies for environmental harm and their efficiency.

3. Social costs of environmental accidents

The social costs of environmental accidents can be broadly classified into three main categories: costs to the victim and costs of precaution (primary costs), costs to allocate the losses (secondary costs) and administrative costs to tackle accidents (tertiary costs). The first category includes pure economic losses (commercial losses, reduction of value of private property, personal injuries), as well as pure environmental losses. While legal rules to ensure responsibility for damage to health and private property caused by environmentally harmful acts have been long developed across countries, the injury to the environment in itself has been recognized as legally compensable

[6] For a complete review of the role of private law concerning environmental damage, see Faure (2011).

[7] For an inquiry into the role of liability to prevent and remedy environmental harm in the EU, see Fogleman (2020).

[8] Helfand, Berck and Maull "The Theory of Pollution Policy" in The Handbook of Environmental Economics, ed. K. Mäler and J. Vincent, 2003, p. 298.

[99] Endres (2011), Xepapadeas 1997.

[10] Cooter and Ulen 2012.

[11] But see on this point Kennedy and Cheong (2013) who tried to overcome the traditional difficulties of non-market valuation through the monetary valuation of ecosystem services.

[12] For a summary of this discussion, see Faure (2009), p. 249.

[13] For a full examination of the likelihood of liability law to pursue optimal deterrence and compensation in the domain of oil pollution damage, see Faure and Hu, eds. (2006).

[14] Faure (2009), p. 247.

only recently[15]. Moreover, pure environmental losses are peculiar because they are dynamic. Pollution is notoriously a kind of harm with progressive tendency. As time goes by, environmental costs increase because more and more goods and services are affected. For instance, toxic substances leaking down into the soil first affect cultivations, then downstream waters and they may in turn cause human diseases to those drinking water or economic losses to the industry (e.g., a close factory producing bottled water). Likewise, toxic air emitted by a factory first hurts workers, then close economic activities and finally the health of close residential people. This trend in social costs may be interrupted by activities aimed at stopping the damage and tackling the risk of additional harm (not just at remedying the previous harm). For that, *time* and *knowledge* about the existing harm play both a crucial role. It is indeed essential that informed parties (polluters, the public administration entitled to control) are correctly incentivised to take immediate action from the first moment they know about the polluting event. Arguably, the expenses referred to this type of action may be quite high compared to others in case of large accidents[16]. While it is true that other branches of law may tackle the time factor (*e.g.,* regulations, urgent direct interventions by public administrations), the border between activities to remedy the existent harm and activities to prevent potential harm matters in view of correctly establishing the polluter's level of care and thus the magnitude of liability.

To conclude, the social costs of accidents to the environment may be classified into costs of initial damage, costs of additional damage caused by lack of activities aimed at stopping its progression, costs to prevent the initial damage, costs to prevent further damage, costs of mitigation and cleanup. Lastly, the benefits of consumers who buy goods and services obtained through risky activities should be taken into account when aggregating all costs of environmental accidents.

4. Remedies for environmental harm

In principle, there are three possible remedies for environmental harm under liability laws:

- **in kind/resource compensation** or **environmental restoration** (obligation to *do* in order to compensate the victims through restoration or replacement of the impaired natural resources);
- **monetary compensation** or **damages** (obligation to *pay* an amount of money equal to the value of the impaired natural resources);
- **combination** of damages and restoration (a partial restoration combined with a compensating payment)[17].

[15] Particularly, the occurrence of large accidents in the end of the previous century has sharpened the need of legal tools aimed at preventing and ensuring remediation.

[16] Paolo Manuelli, 'Assicurazione-Ambiente-Le spese per impedire o diminuire il danno da inquinamento' [2000] *Ambiente e Sviluppo* 1(43). For instance, the Sandoz accident of 1986 was followed by a very high number of claims for damages ranging around 25 million euros. However, the money needed to stop water contamination and preserve the healthy state of ecosystems represented a separate head of damages.

[17] Alan Randall, 'Whose Losses Count? Examining Some Claims about Aggregation Rules for Natural Resources' [1997] 15(4) Contemporary Economic Policy 88, 88.

The most common remedy for liability is given by monetary compensation or damages. In the economics of torts, the term "*damages*" refers indeed to the amount of money for which the injurer is legally liable towards the victim of an accident[18].

With special regard to environmental harm, monetary compensation consists of estimating the value of natural resources via economic valuation techniques[19]. Environmental economists developed various methods to value the environment, each of them holding a different degree of accuracy and reliability. Notwithstanding the differences, the goal of all nonmarket valuation techniques is to elicit *individual preferences* over environmental goods and services through *individual choices* which are then used to infer *individual economic values*. Economic values may be defined as the "*expression of the intensity of individual preference*"[20] and they can be distinguished between use and non-use values[21]. The quantification of environmental harm is therefore based upon these values[22]. Yet, money presents some well-known limitations. First of all, it is well-known that monetary compensation for nonpecuniary losses can rarely achieve full victim compensation, while only representing an 'approximate' full restitution. Moreover, it can be totally inadequate if the value of goods or services is not measurable in economic terms. Lastly, compensation may satisfy one or some individuals but not the general public.

An alternative remedy is given by 'in kind restitution' which can be achieved through injunction to restore. 'In-kind/resource compensation' is indeed a typical non-monetary remedy in tort law and its aim is to remedy nonpecuniary losses. With special regard to environmental harm, restoration may be defined as the process aimed at compensating an ecosystem for outside influences, so that it "*can continue to behave or resume behaving as if these were not present*"[23]. For this reason, restoration projects initiate or accelerate the recovery of an ecosystem with respect to its health, integrity and sustainability[24]. They may consist of a set of practices, such as erosion control, reforestation, removal of non-native species, reintroduction of native species, revegetation and habitat improvement for targeted species. This remedy tends to be preferred to monetary compensation for environmental damage because it overcomes the above-mentioned limitations of paying an amount of money for nonmarket goods. Moreover, restoration is considered to be cheaper and easier to apply. Last but not least, restitution in kind allows to avoid further damage to the environment, hence being more likely to minimize the costs to the environment. Given the

[18] Shavell (2004), p. 236.

[19] According to Kontoleon (2002), economic valuation strategies are only one of the possible ways to take environmental decisions. Participatory/deliberative approaches and expert-based approaches are others methods of decision making.

[20] Kontoleon, A., Macrory, R., & Swanson, T. (2002). Individual preference-based values and environmental decision making: Should valuation have its day in court? In Research in Law and Economics (Vol. 20), p. 181, https://doi.org/10.1016/s0193-5895(02)20009-3.

[21] Very broadly, the former relate to the direct use of services produced by natural resources (e.g., recreation) and the latter to individual values that have nothing to do with the current, potential and future use of those services. The former include direct, indirect and option (that is the potential use) values, while the latter include existence and bequest values.

[22] It is beyond the scope of this dissertation to question the suitability of "economic values" in the context of the environmental decision-making. However, for a review of the long-standing debate around conceptual, moral and legal issues of economic values for environmental goods and services, see Kontoleon *et al. op. cit.,* p. 181ss.

[23] Jordan, W. R. III, and Lubick, G., (2011). William R. Jordan III was the American botanist who developed the new approach to restoration that considerably influenced the environmentalism in the US and abroad. He was among the founding members of the Society of Ecological Restoration and he is considered to be the current world leader on restoration. The citation comes from Goedeke T.L. and Rikoon, S. 2008, p. 111.

[24] Society for Ecological Restoration International Science & Policy Working Group (2004).

difficulties raised by monetary awards, restoration has gained a primary role as a remedy for environmental harm[25].

5. Summary of the economic discussion on remedies (state of the art)

The aim of this paragraph is to provide a summary of the economic discussion on remedies in the specific domain of environmental liability.

There is a wide literature of law and economics on the level of precaution (*i.e.*, *ex-ante* measures) induced by various levels of liability all based on the actual level of harm (*ex multis,* Shavell 2004, Visscher 2009).

Fewer contributions focused instead on the consequences of *ex post* measures, such as cleaning-up accident sites, and liability regimes based on the clean-up level rather than the actual level of harm (Endres and Friehe 2015). However, it remains unclear whether liability based on clean-up costs is likely to provide not just optimal incentives to prevent accidents and/or to ensure compensation at the lowest cost. Given that restoration is the primary remedy for environmental harm in the majority of legal systems, this research gap needs to be addressed. I start from providing a short review of the main scholars who wrote on both issues.

5.1 Liability based on the level of harm (damages)

First of all, liability laws can provide optimal incentives of care and activity only if accidents result in one possible level of harm and the magnitude of liability equals that level of harm[26]. As a consequence, if an accident can result in more than one level of harm, injurers can take optimal decisions only where the expected magnitude of liability equals the expected harm (actual level)[27]. This means that incentives to reduce risks will be inadequate every time that liability falls short of expected harm (too low incentives) or, by contrast, liability exceeds expected harm (too high incentives). However, the principle of matching liability with the expected harm may be suboptimal in the following cases: a) if the possibility of certain accidents is overlooked (because a lower liability would not decrease injurers' incentives)[28]; b) if the possibility of an accident cannot be reasonably foreseen (exceptional cases)[29]; c) if the possibility of some accidents is very high (because matching liability and actual harm would induce injurers to adopt excessive care).

The principle of matching expected liability with expected losses does not change in case of courts' uncertainty about the level of losses. More in details: a) injurers will be led to act optimally even under courts' uncertainty if courts use estimates of losses that are correct *on average*[30]; b) administrative costs will not increase too much if courts *exclude* from damage computation *uncertain*

[25] Wendel 1991, Cross 1989.

[26] Shavell (1987).

[27] Shavell (1987), p. 236. Consider that "*expected losses are a probability-weighted aggregation of losses that can arise in many individually unlikely ways*" (p. 238). For this reason, it would be unacceptable to limit liability because of the low probability of losses.

[28] But see Shavell (1987) p. 239 for additional consequences, such as the increase of litigation costs.

[29] *Ibidem,* p. 239.

[30] Shavell (1987), p. 241. Moreover, Cooter pointed out that courts need to calculate damages in an accurate manner only under a strict liability regime. In fact, only under strict liability, injurers are responsive to errors in computing damages and assigning liability, whereas under negligence they are more responsive to the (1984, p.).

components of loss whose *probable magnitude* is low[31]. However, the superior approach to courts' uncertainty would be to *approximate uncertain components* through easy formulas and to avoid parties' disputes in litigation[32].

Other relevant issue is the distinction between pecuniary and nonpecuniary losses. Pecuniary losses concern goods that can be produced and consumed in markets; therefore, their value can be either measured as wealth reduction or as replacement cost[33]. Nonpecuniary losses relate instead to irreplaceable things, whose value is not directly and objectively measured. This is the case of losses affecting individuals' health, physical and mental integrity. The basic economic analysis of tort law argues that the magnitude of liability has to include pecuniary and nonpecuniary losses as they both reduce social welfare[34]. However, nonpecuniary losses are clearly more difficult to measure. From an economic point of view, it would therefore make sense for courts to try to estimate them only in case of large losses. If losses are small it would be better to exclude them from the calculation given that incentives to reduce risk would be only slightly affected and administrative costs would be saved. However, as with uncertain losses, the superior approach would be to resort to simple tables and formulas to measure small nonpecuniary losses. By contrast, if losses are large, it is better if courts try to estimate them otherwise incentives to reduce risk would be seriously affected.

Finally, victims can take various actions to mitigate losses after accidents occur. These actions are genuinely distinct from taking care before accidents occur in order to reduce their likelihood. In view of minimising total social costs of accidents, including victims' costs to mitigate losses, it would make economic sense for victims to invest in loss mitigation up to the point where the marginal cost of doing so matches the marginal benefit, which is the reduction in loss. So, if the expected harm without mitigation would go up from 100 to 150, then it would be socially desirable if the victim invest in mitigation up to 50. This is not irrelevant to our discourse. If the goal is to minimise the total social costs and they include the expected (actual) cost of harm (direct losses) plus optimal mitigation costs, the optimal level of care of injurers should take into account this last sum. In the perfect world, victims will be induced to take optimal mitigation actions and injurers to choose the optimal level of care as if victims had optimally mitigated their losses. Knowing that, victims will spend optimal costs in mitigation and they will be fully compensated in the end[35].

Cooter and Porat (2001) analysed nonlegal sanctions (reputational consequences) that in addition to money may affect the behaviour of injurers.

5.2 Liability based on the level of clean-up (restoration)

With the term "clean-up" we refer to "*any activity that reduces harm after the discharge has occurred*"[36], such as the removal of the polluting substance from the damaged natural resource, the establishment of rescue centres for birds and animals, the reintroduction of fish, the construction

[31] *Ibidem.*

[32] *Ibidem.*

[33] *Ibidem.*

[34] Shavell (1987), p. 242.

[35] As Shavell points out, the Anglo-american and French legal systems tend to establish the size of awards assuming that injured parties take optimal mitigation actions (1987, p. 249).

[36] Polinsky and Shavell (1992), p. 1.

of barriers to reduce the diffusion of waste in the soil. Clean-up, precaution and consumption of the goods whose production gives rise to environmental accidents determine the level of environmental damage[37].

The standard economic model of liability is based on fixed levels of harm and clean-up activities have been mainly analysed by law and economics scholars to examine the incentives to acquire contamined sites (Sigman 2010), the role of joint and several liability (Chang and Siman 2007), the incentives to clean-up in case of self-reporting of infractions (Innes 1999).

Polinsky and Shavell (1994) for the first time[38] applied the economic theory of liability to environmentally harmful discharges when post-accident mitigation of harm by clean-up activities has a considerable effect on social costs. They thus examined how liability rules may affect injurer's incentives to clean-up and concluded that a regime of strict liability based on the level of clean-up plus the remaining harm would lead firms to adopt socially optimal decisions on both care and clean-up[39].

Barrett and Segerson (1997) considered the use of multiple policy instruments to tackle one single environmental problem.

Endres and Friehe (2015) compared the incentive effects of liability regimes based on the level of harm or on clean-up costs on both injurers and victims. In fact, they considered the real case in which victims' care may also influence the actual level of harm.

Given that restoration includes clean-up, it is possible to assume that liability based on clean-up is approximately the same as liability based on restoration costs. Drawing on this assumption, the stream of literature on clean-up will be employed to compare the incentive effect of the two remedies (monetary compensation and restoration).

6. Inefficiency caused by divergence expected damage – damages (from the perspective of the polluter)

The previous paragraphs introduced the three main pillars upon which this theoretical chapter is built: the goals of environmental liability, the social costs of environmental accidents and the remedies available to minimize social costs. Moreover, paragraph 5 summarised the state of the art in the economic scholarship of remedies for environmental liability. The next step is to illustrate in depth one of the main issues of inefficiency, *i.e.* the divergence between magnitude of liability and magnitude of harm. Based on that, paragraphs 7 and 8 will tackle how precisely this divergence may be determined by looking at the two considered remedies for environmental harm (damages and restoration).

In case of damage and liability, it is assumed that the polluter has to compensate the injured party for the exact damage. However, a number of issues might occur determining a divergence between the expected level of damage and the expected level of compensation payment. The issues causing a departure from the principle of full compensation have been summarized by Endres (2011) as it follows.

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[37] *Ibidem.*

[38] For previous scholars carrying out research on environmental discharges, but for different purposes, see Polinsky and Shavell (1992), p. 2, footnote 1.

[39] Rephrasing Polinsky and Shavell (1992), p. 4, cleanup expenditures should be undertaken up to the point where the marginal reduction in harm is equal to the marginal cost of it. Likewise, care should be undertaken up to the point where the marginal reduction in expected harm and clean-up equals the marginal cost.

Information problems may affect the level of expected payment in two ways. First, because risky activities are not fully observable, potential claimants of environmental damages may lack sufficient knowledge in order to file a lawsuit. As a consequence, polluters may be aware of that and take decisions about their level of care and activity based on the level of expected damage corrected by a probability of being detected lower than 1. Information problems also arise in litigation because parties might bear opposite arguments to support divergent estimates (smaller from the perspective of the injurer and larger from the perspective of the victim). Because of that, courts might incur in errors while quantifying the damage[40].

Motivation problems induced by higher transaction costs than the expected compensation payment might determine the socalled "rational disinterest" of parties in enforcing their claims[41]. This is particularly true in the case of damage spread across many people and can be avoided by resorting to *class actions*[42].

Imperfect property rights may also represent a cause of divergence, because under a liability rule the polluter compensates the victim for the damage caused to the extent that the victim is entitled to claim compensation. If there are no property rights over the impaired natural resources, than the victim has no standing in liability lawsuits. This may be avoided by setting down by law who is entitled to claim compensation for environmental harm[43].

Limitations of liability also cause a departure from full compensation. Such constraints on polluter's liability may be provided by liability laws or by rules governing the legal form of firms. Law and economics scholars have been long investigating whether it is possible to internalize externalities where the levels of firms' assets are critically low. Scholars particularly suggested to extend liability to creditors (lender liability) or to introduce mandatory insurance[44].

The effect of all these cases of divergence between damage and compensation can be readily summarized.

Given that in traditional economics the decision maker only seeks to minimize his costs (and not to fully compensate the victim), the polluter always looks at the level of compensation payment rather than the actual level of damage. He therefore chooses a level of pollutant emission such that the sum of abatement costs and compensation payment is minimized. It can be implied that if the expected level of compensation is below the expected level of harm, the chosen emission level will be above the optimal one and there will be too high emissions[45]. The more the compensation payment lies below the level of damage, the more the equilibrium emission will be compared to the optimal level.

However, if the polluter's liability is limited, the divergence between damage and compensation payment occurs only where the damage exceeds the maximum amount set as upper liability level. More precisely, the polluter can adopt an optimal emission level (the one that minimizes the sum of abatement costs and payment for the damage caused by that emission level) only where the

[40] Marcel Boyer & Donatella Porrini, 'Optimal Liability Sharing and Court Errors: An Exploratory Analysis' 2010 CESifo Working Paper Series 3073, CESifo.

[41] Ott/Schäfer (2004).

[42] Endres (2011), 61.

[43] For instance, the EU directive on environmental liability designates the public administration as trustee of natural resources.

[44] Feess and Hege (2000).

[45] Endres (2011), pp. 62-63. It must be noted that the level of emissions is in any case lower than in a scenario where no environmental policies are in place. However, the objective of fully internalizing the externalities is not achieved.

damage caused is below the compensation level. Whereas, if the damage is above the compensation level (as it is for very high emissions) the minimum is where the polluter avoids all abatement costs and he only bears the maximum damage compensation. The precise equilibrium level will then depend on the level of limitation and it should be set high enough to induce the polluter to adopt the socially optimum emission level.

The effects of divergences between compensation and damage tend to change under more realistic scenarios, such as multicausality and information asymmetries as to the standard of care.

While the basic economic model assumes that one polluter causes damage to one victim, it would be more realistic to consider that the environmental damage is normally caused by various polluters and it tends to affect more than one victim. Multicausality then leads to different conclusions as to the internalization effect of liability rules. Like in bilateral damage, where the level of damage depends on the level of care undertaken by both the injurer and the injured party, the liability rule has to incentivize both parties to act with care. So, a strict liability rule should be supplemented by a "contributory negligence clause" (at the socially optimal level) on the part of the injured party[46].

Having said that, the next two paragraphs will list more specifically the factors causing divergence between magnitude of liability and magnitude of harm in case of monetary compensation (par. 7) and restoration (par. 8).

7. Economic issues of monetary compensation/damages

7.1 Inaccuracy

The first issue raised by monetary compensation concerns the accuracy of stated preferences methods, such as contingent valuation. According to the NOAA panel, surveys can create incentives to express truthful preferences provided that they are properly designed. In other words, the quality of the survey design determines its validity. Moreover, the size of the sample can reduce the margin of error and raise the level of reliability. Arguably, for some scholars the level of accuracy in courts should be higher compared to policy purposes. That is because errors of cost benefit analyses can be spread across large populations, whereas judicial errors are born by single or few responsible parties. Likewise, from a law and economics viewpoint, errors should be avoided if they lead to large over- or underestimation of the level of damage. However, the improved level of accuracy needs to be weighed against the increased costs of valuation.

7.2 Costs of assessment

The second issue raised by monetary valuation is indeed given by the costs to undertake the study[47]. From a purely economic perspective, they should be avoided if they exceed the damage

[46] In bilateral accidents, strict liability does not provide both parties to adopt optimal levels of care because the injured party gets compensation for the damage irrespective of his level of care. This means that the care level of the injured party is likely to be socially suboptimal. Fees and Hege (2002) also demonstrated that an efficient solution in the short term can be also achieved if the polluter is responsible for the whole damage. Yet, this may cause misallocations in the long term and a violation of proportionality principles (Endres 2011, p. 66, at footnote 64).

[47] Under the ELD, " *'costs' means costs which are justified by the need to ensure the proper and effective implementation of this Directive including the costs of assessing environmental damage, an imminent threat of such damage, alternatives for action as well as the*

itself[48]. For this reason, it would make economic sense to undertake expensive environmental valuations to estimate the monetary value of the damaged natural resources only where the accident caused extremely high costs to the environment[49]. As a consequence, the usefulness of environmental liability would be drastically reduced. It is true that alternative and cheaper methods of monetary compensation are available (*e.g.,* benefit transfer method)[50], but they are likely to cause more errors because of their lower degree of accuracy. Therefore, accident costs that would be left uninternalized because of errors are more likely to outweigh the benefits (costs saved in litigation). Unluckily, the issue of costly (but accurate) monetary estimates has not be solved, yet[51].

7.3 Uncertainty about the population affected

The third issue is uncertainty about the population affected by environmental harm. This is very important because the process of environmental damage assessment is not aimed at measuring the unit average damage (through sampling), but the total amount of damages (through aggregation)[52]. In other words, after it has been established how to determine the payment sufficient to compensate the unit[53], the second step would be to aggregate damages across units in order to obtain the total value of damage. It is thus crucial then to identify those whose preferences matter and that should be included in the aggregation population because they suffered a real loss of welfare from the accident[54]. While much of the debate in welfare economics traditionally focused on the first step of this process, also the second step attracted much debate particularly around the categories of benefits that may offset the damages and the reasons to exclude the losses of certain classes of households.

Assuming that valid and accurate measures of damages are available for all relevant units (a method to obtain accurate estimates exists and the willingness to pay to prevent the injury is equal to the willingness to accept compensation), it is possible to focus on the issue of which categories of damages should be aggregated.

However, drawing on the welfare theory, the value of natural resources mainly depend on their use or consumption even if there are very importantly valued natural resources (*e.g.*, biodiversity)

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administrative, legal, and enforcement costs, the costs of data collection and other general costs, monitoring and supervision costs" (Art. 2, §16).

[48] Shavell (1993).

[49] *Ibidem.*

[50] In view of minimizing these costs, the White Paper originally endorsed the benefit transfer method rather than original valuation studies which are more time-consuming and resource-intensive. However, the accuracy of the method was at that time highly debate. On this point, Stale Navrud, 'Environmental Valuation – To Use or Not to Use? A Comparative Study of the United States and Europe' [1997] 10(1) Environmental & Resource Economics

[51] According to T Swanson and A Kontoleon, *supra,* 15, economic valuations of public goods in courtrooms are a "*poor substitute for adequate environmental regulation ex ante and ex post*".

[52] Randall (1997), *supra*, 88. (Welfare) economists think of natural resource damage assessment in terms of Kaldor-Hicks compensation. That means to first determine the payment to compensate the unit and, then, to aggregate damages in order to obtain the total value of damage. Assuming that methods to estimate accurate and precise estimates of unit damages exist (*i.e.,* set aside issues of measurement and the distinction between the value of damage and the willingness to pay to prevent an injury), much controversy has arisen regarding aggregation because of offsetting benefits and damages claimed by certain categories that should be excluded. As to offsetting benefits,

[53] Most of the debates about the assessment of natural resources damages concern this very first step. See Chapter 3 for a summary of this discussion.

[54] It should be noted that the economic concept of standing should be deemed as much broader compared to the legal one which includes only those who suffered a legally compensable damage and that are therefore entitled to file a lawsuit.

that exist regardless their current or future human use. If the injury occurs to these types of resources, the subsequent issue is clearly how to select nonusers. A first criterium may be given by the existence of rights. Yet, nonuse values exist precisely when there is no present or future use of natural resources, so it is highly unlikely that claimants of nonuse values hold rights over the environment. Alternatively, some scholars have argued that prior knowledge about the impaired resources should be a prerequisite to claiming a loss of nonuse values[55]. Indeed, the search of information involves opportunity costs and, therefore, it is a signal of interest for them[56]. A caveat should be just that knowledge has not be specific[57]. Moreover, it should not be induced by surveys like with the implementation of new environmental policies. Aggregating losses over previously uninformed people is reasonably inappropriate when assessing *ex post* compensation for actual welfare losses[58].

7.4 Compensatory goal

The last but not less relevant issue is consistency between economic valuation of the environment and the 'compensatory objective' of liability. A first argument against consistency from a legal perspective would be that values expressed after the occurrence of accidents might not be in line with pre-existing values which are totally independent of the accident[59]. Moreover, also from an economic standpoint, the willingness to pay to avoid damage is a different welfare measure compared to the change in value of a good or service as a result of an accident[60].

8 Economic issues of 'in kind' restitution/reparation/restoration

8.1 Inaccuracy

First of all, costs of restoration are independent from the value of natural resources[61]. They can be greater or lower compared to the value of damage, but in any case totally unrelated. Moreover, they do not cover interim losses which are the costs occurring until full recovery.

Correlation between costs of restoration and the marginal value of damage function

Randall 94, model by McConnell at 95

As to the notion of baseline, there are several uncertainties that may in turn determine uncertain costs to restore.

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[55] Richard W Dunford and others, 'Whose Losses Count in Natural Resource Damages?' [1997] 15(4) Contemporary Economic Policy 77; F Reed Johnson and others, 'Role of Knowledge in Assessing Nonuse Values for Natural Resource Damages' [2001] 32(1) Growth and Change 43

[56] This is exactly because of the definition of "passive use value" as the value (satisfaction of preferences) derived from just knowing (Alan Randall, *supra,* 92).

[57] If people care about a class of environmental goods, it is possible to infer that they also care about particular assets within that class (Alan Randall, *supra,* 93). However, for a counterargument to this conclusion see Johnson and others, *supra,* who argue that care about classes does not solve the problem of understanding whether people equally care about all species within that class and, thus, how much they should be compensated for a

[58] Richard W Dunford and others, *supra.*

[59] John F Daum, 'Some Legal and Regulatory Aspects of Contingent Valuation' in Jerry A Hausman (ed), *Contingent Valuation: A Critical Assessment* (vol 220, Emerald Group Publishing Limited 1993)

[60] Edward J Yang, 'Valuing Natural Resource Damages: Economics for CERCLA Lawyers' [1984] 14 Environmental Law Reporter 10311

[61] *Ibidem.*

First, should restoration costs include the costs to restore the environment until its pristine conditions? Legal and economic views converge on this point and they recommend that the only aim of restoration should be to bring the environment back to the baseline (condition that would have existed if releases of hazardous substances had not occurred). Conversely, the polluter will internalise more than the damage that he could prevented and he will respond to a share of harm that was not causally linked to his negligence. The subsequent result would be overdeterrence and inefficient incentives of care and activity. A typical case may be given by all natural resources that have been adversely affected by other events (e.g., urban development, highway constructions).

Secondly, should restoration include just the costs to restore the services or also the costs to restore the physical, chemical and biological conditions of a natural resource[62]? If, for instance, the injury is represented by water pollution, then it is unclear whether the goal of restoration should be to repair just the service provided by the water or also the quality of the water. The issue slightly differs from the previous about the baseline because repairing just one service provided by a polluted river could represent only a partial activity to bring the environment back to the baseline. However, restoring the quality is clearly more expensive and it would require data on the quality of the baseline that may not be available.

Thirdly, should restoration include both the active and the passive value of natural resources until recovery? This distinction has been tackled both in the U.S. jurisprudence and doctrine. To sum up, while the aim of the environmental damage assessment should be to cover at least the diminution in market price of the destroyed natural resources, it is also true that a reasonably competitive market for resources does not always exist or it exists but natural resources have values that are not fully measured by the market[63].

In any case, baseline conditions tend to be uncertain due to lack of technical data, meaning that there is often a lack of standards against which progress can be measured and monitored.

Lastly, it has been pointed out that, once cleanup is completed, either residual contamination may remain that presents an injury to the environment or a cleanup may successfully remove or isolate all or most of the contamination but natural resources may not be restored to the condition that would have existed if releases of hazardous substances had not occurred (baseline condition)[64]. So, restoration may not bring the environment back to the baseline also where natural resources are not unique and irreplaceable.

8.1 Costs of restoration

Restoration costs clearly depend on the available manpower and equipment, on the level of technology and, hence, indirectly on the agency's budget, the frequency and volume of spills to be tackled. Clearly, costs of restoration are higher if one wants to achieve cost-effective remediation and optimal deterrence (also including costs of monitoring after the implementation of restoration

[62] Ward 1998.

[63] "*The value of an otter is greater than the value of its pelts"* (Ward 1998, 107).

[64] Ward 1998. In the words of the author: "*if stream side tailings leach hazardous substances into a river, the removal of the tailings may protect the public health from continued releases, but it may not restore the river. The river sediments, macroinvertebrates, and fish downstream from the tailings may remain injured. Until those resources are restored, there can be a continuing injury for which restoration costs may be recovered. Additionally, damages may be recovered for the lost use and other values of an injured resource until it is restored.*"

plans). Costs of restoration may be also higher due to the private interests of agencies responsible of cleanup activities.

An additional issue is that the restoration cost approach may ignore the probability of natural recovery. If the environment has the potential of coming back to original conditions over a period of time and without the need of human intervention, then paying costs of restoration would be a waste of money and it would make sense just to pay interim losses until full (natural) recovery.

A very last point to consider about the costs of restoration is that decisions on restoration are unlikely to be automatized due to their complexity. It may be implied from the above that decisions on restoration require a careful consideration of technical, scientific and financial issues. Therefore, the possibility of speeding up litigation by employing algorithms would not be applicable to restoration as a remedy. That seems to be possible only in case of monetary compensation[65].

Comparison with restoration under private governance,
Richardson, p. 235

8.2 Uncertainty about the affected population

Population's preferences about the goods and services to restore are uncertain. Based on the possible goals of restoration, ecologists tend to distinguish an ecosystem-centred approach from the so-called "socio-ecological restoration". The former only look at restoring ecological health, while the latter simultaneously deals with social and ecological issues and their main goal is to jointly restore the interdependent social and ecological processes in a social-ecological system (SoES)[66]. Socio-ecological restoration implies difficult choices between human well-being and ecosystem recovery, but it is more adapted to areas, like wetlands, coastlands and terrestrial ecosystems that have been historically shaped by humans and whose conservation and management relies on them[67]. Based on that, the choice of a specific restoration project in litigation implies a choice of the goals that one wants to pursue through restoration, meaning that it is up to the judge (or the expert) to determine the categories of people whose losses will be restored.

The second limitation of injunctions is connected to the characteristics of the legal process, the existence of strategic dynamics and the tendency to overstate private interests. Like for monetary compensation, the judge has to strike a balance between conflicting interests also in case of restoration orders[68].

Moreover, it is possible that a long-term conflict arises with the goals of environmental policies as set down by legislators under democratic procedures[69]. Such a conflict may be avoided only by limiting the scope of private actions and using them as simple triggers of enforcement. However, it would be highly unlikely that private interests of claimants for environmental damages will be aligned with the general goals of environmental policies[70].

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[65] See the U.S. legislation on environmental liability.

[66] Fernández-Manjarrés, Juan F.; Roturier, Samuel; Bilhaut, Anne-Gaël (2018).

[67] *Ibidem.*

[68] However, similar issues may occur in lawsuits based on claims for damages.

[69] Pfenningstorf cit., 356. Interestingly, the risk of a judiciary acting against legislators has gained a totally different perception after thirty years on this side of the ocean. The same fact that judges may walk opposite roads compared to national or local policies seems to be the most viable solution against policy-makers which are reluctant to undermine private interests of polluting industries.

[70] According to Pfenningstorf, allowing simple petitions would keep stable the substantial and procedural framework of the system.

8.3 Compensatory goal

It has been said that monetary compensation may not be in line with the compensatory objective of liability laws because the economic valuation of natural resources is represented by a welfare measure other than pre-accident preferences[71]. However, the same argument also applies to restoration. If one looks more carefully at the decision-making on restoration, restoration projects need to be "scaled" and the scaling process relies on economic values that are clearly based on the individual willingness to pay, like for monetary compensation[72]. Moreover, restoration projects should be excluded if their cost is disproportionate compared to the economic value of the natural resources to be restored. For this reason, economic values have to be employed also in view of this outcome.

Lastly, the possibility of replacing the injured resources with substitutes is clearly limited by the availability of replacement resources. This is specifically true in case of accidents to unique environments, like Natura 2020 sites in the E.U.. As a consequence, in kind restoration of unique and irrecoverable ecosystems cannot provide compensation. Having restoration as unique remedy in these cases would further incentivize the causation of damage up to irreversible conditions if costs of restoration in the end may be lower than the (immeasurable) value of irrecoverable harm.

To conclude, the same issues determining the inefficiency of monetary damages also occur in case of restoration orders The next step would be therefore to investigate whether an optimal scenario exists such that restoration may achieve optimal deterrence and adequate reparation.

9 Optimal setup

The aim of this section is to describe the perfect conditions under which (all types of) remedies for environmental harm are likely to induce parties to adopt socially optimal levels of care and activity, so that both goals of environmental policies can be achieved: deterrence and restoration.

We assume that environmental accidents are bilateral, meaning that both injurers (polluters) and victims (public administrations on behalf of the society) can invest in *ex ante* care to lower the likelihood and magnitude of harm[73]. However, it is highly likely that only the injurer's care can influence both the probability and the magnitude of harm, whereas the victim's care may only affect the latter[74]. Moreover, in this setting there is only one injurer who can cause the harm and more than one victim likely to be harmed and there is no uncertainty about the causality linkage between accident and harm. Moreover, victims can mitigate the harm *ex post* through clean-up measures. More specifically, in contrast to conventional law and economics models (Shavell 2004), full compensation of harm cannot make the victim as well off as before accidents, since there

[71] See above on the economic issues of monetary compensation.

[72] Nicoll The Irrationality of rationality in restoration 2000, 481

[73] Shavell (1987), p. 182. According to Polinsky and Shavell (1992), the damage from environmental discharges depend on: clean-up, precaution to prevent them and the level of consumption of the goods whose production gives rise to the discharge. For this reason, the society which suffers losses from accidents contribute to the harm itself if it does not change its consumption tendencies.

[74] Endres and Friehe (2015).

would be an additional share of social costs (the remaining harm after clean-up) that only the victim can avoid by taking care[75].

Both parties have perfect information about legal rules, accident risk, baseline conditions, clean-up techniques and precautionary measures. There is no risk of historical or accumulated damage, since every accident is reported and tackled immediately by public authorities (no historical or accumulated damage). The regime is of strict liability, with the noted consequences in terms of judicial errors[76]. The probability of detection is equal to one and parties have optimal incentives to sue and go to trial (no settlement). Finally, the injurer is fully solvent.

Considering that social welfare is equal to the utility of individuals less the costs of production and the costs associated with the damage, this contribution keeps as final goal the maximization of social benefits or the minimisation of social costs (Pareto optimality).

Finally, we assume that the decision-making on pollution control is double-phased or sequential. In the first stage, the injurer and the victims take a simultaneous decision on care. In the second stage, only victims take decisions on the amount of clean-up to undertake, based on the previous precautionary level and the liability regime[77]. Moreover, the amount of clean-up costs depend on both the removed harm after the accident and the level of initial harm. So, the higher the initial harm the higher the clean-up costs. A lower level of initial harm would be thus more desirable and it could be obtained by increasing injurer's incentives of care.

Within this setting, Endres and Friehe (2014) inferred the following conclusions.

First, when liability is based on the actual level of harm, victims are induced to invest in care to reduce the remaining (expected) damage after compensation, if the level of initial environmental harm is large and the level of clean-up costs reacts strongly to changing levels of environmental harm[78].

Secondly, when liability is based on the level of full clean-up and the cost of clean-up is greater than the level of harm, injurers' incentives are stronger under this regime rather than the previous (liability based on harm). That in turn reduces the level of environmental harm and lower victims' incentives of care if clean-up costs react strongly to changes in the level of harm.

Thirdly, when liability is based on clean-up costs actually incurred by the victim and proved in the courtroom, the victim will find privately optimal to ensure a full clean-up even if this is socially inefficient (incentives for victim care are distorted). This regime actually leads to suboptimal results compared to the previous one based on the full clean-up. However, this is the most widely used regime across jurisdictions.

Fourthly, when liability is based on both clean-up costs and the remaining level of harm, the level of precaution of the victim goes down to zero. This regime is socially desirable if the injurer's care has a major influence on social costs[79].

Finally, if liability is fixed ex ante and not based on clean-up costs nor on harm, the injurer and the victim will receive privately optimal incentives of care which are independent from the behaviour of the other party and will be increasing in the level of required fixed compensation. This regime

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[75] Endres and Friehe (2015), p. 107.

[76] See above, footnote 30.

[77] Here, we assume that after the occurrence of environmental accidents, the harmed party takes imminent clean-up to remedy the damage and avoid further consequences.

[78] More technically, "*if clean-up costs react strongly to changes in the level of environmental harm*" (Endres and Friehe 2015, p. 113).

[79] To be more precise: "if *the marginal influence of victim care on the level of environmental harm is negligible for non-negligible levels of injurer's care*" (Endres and Friehe 2015, p. 118).

is ideal when victim's care is of overriding importance, because its best response to the injurer's care is similar to that of the policy maker. Yet, high information costs are on the policy-maker. Based on the above, it would make sense to opt for liability based on harm plus actual clean-up costs if one wants to achieve socially optimal levels of injurer's care, whereas the fixed liability regime works better if one wants to achieve socially optimal levels of victim's care.

10 Imperfect scenarios

Various issues may significantly change the equilibrium setting illustrated above. While the optimal setup represents a blueprint, the following scenarios are conceptualised on the basis of real-world circumstances.

10.1 Asymmetric information about the damage

In many cases, it is not possible to estimate the whole environmental harm caused by accidents. Regulators may be missing information about the exact time when accidents occur or about baseline conditions prior to accidents. May be, it is technically impossible to measure the extent of the damage (e.g., water pollution) or the impaired resource was unique because of a high level of biodiversity. All these issues may determine inaccurate (too low or too high) assessments of harm, which in turn lead to suboptimal incentives of care and activity.
If the information asymmetry concerns the cost of damage, two possible scenarios may occur:

- **S > R > M** (cost of environmental damage > cost of restoration > monetary damages)
  A typical case of this situation is the harm to natural resources that can be only partially restored (unique resources) and a considerable share of value cannot be estimated.
  In this case, M would not fully internalise the externality, hence failing to achieve optimal deterrence. At the same time, R would not fully restore the environment as it was before the accident. Apparently, neither a liability regime based on the level of harm nor a liability regime based on clean-up costs seem able to achieve any of the two policy goals[80]. However, Endres and Friehe (2015) examined the change in incentive effects of the various liability regimes in case of "incomplete compensation"[81]. They found that victim's incentives for clean-up remain socially optimal under a regime of liability based on (incomplete) harm, whereas injurer's incentives are more likely to be suboptimal. The same happens with liability based on clean-up costs, but repercussions are expected to be more important[82]. Based on the above, a regime of liability based on harm would leave unchanged the incentives of the victim to undertake optimal clean-up. So, it would be more socially desirable to opt base liability on harm (although underestimated) and not on clean-up costs if the effort of the victim to reduce further social costs by undertaking optimal clean-up is more important than the investment in care by the injurer. Conversely, if the accident is such that the effort of the victim has no impact on the final total social costs, then there will be no great difference between the two remedies in terms of optimal

[80] Polinsky and Shavell (1992), p. 9.
[81] Endres and Friehe 2015, p. 121.
[82] *Ibidem,* p. 122.

prevention. However, restoration should be maintained as a remedy for the part of damage that is technically restorable.

- **S > R = M** (cost of environmental damage > cost of restoration = monetary damages)
  A typical case of this situation is the damage to areas that are unique or that hold a considerably high level of biodiversity.
  In this case, restoration is impossible and optimal deterrence very hard to achieve. More precisely, restoration cannot bring the society to the same level of utility as it was before the accident. On the other hand, monetary remedies are unable to capture the whole value. However, comparing R and M, it is possible to argue that monetary compensation is likely to make the society **better off**, because it can choose whether to invest the money in other environmental projects or set it aside for future social needs. On the other hand, a fixed *ex ante* monetary sanction would push the parties to undertake optimal prevention.

10.2 Low probability of detection

Firms may escape liability after accidents for multiple reasons. It may be hard to discover the accident, e.g. a polluting substance dumped into the ocean. It may be impossible to identify the polluter because many companies employed the same polluting substance for many years. In these cases, the effects on firms' behaviours are the same as with insufficient assets (see below). In order to offset the lower probability of detection, the magnitude of liability should be increased according to the optimal penalty model by Becker (1968). In other words, the polluter should be obliged to pay or restore for an amount of money that is higher than the expected damage. Alternatively, given that potential injurers respond (rationally) to both probability of detection and severity of punishment, government enforcement should become more effective in preventing accidents by increasing the sanctions, as well as by investing in monitoring activities that raise the likelihood of punishment. Enforcement should be increased up to the point where the marginal cost of it equals the marginal benefit of damage reduction.

In this scenario, the only remedy of environmental restoration cannot optimally deter polluters and a smart combination of restoration and monetary compensation would be needed.

10.3 Polluter's insolvency

Given that the harm caused by environmental accidents can be considerable even for a small scale of operations to prevent it, firms' assets would not be sufficient to pay for the harm in many cases. If the harm greatly exceeds the asset of the polluter, it has been demonstrated that the injurer is likely to take suboptimal care and clean-up under a regime of strict liability, while he is more likely to take optimal care and clean-up under negligence. So, the negligence rule is likely to be "less inferior" compared to strict liability in these cases[83]. However, none of the regimes would achieve optimal deterrence. The question of course arises whether compensation for oil pollution damage should merely be provided via liability rules or also through traditional insurance. Also, fund solutions can be implemented to deal (partially) with oil pollution damage. An open question

[83] Polinsky and Shavell (1992), p. 8.

is therefore how an optimal combination of liability rules, insurance and fund solutions can be put into place in order to provide adequate compensation[84].

The function of liability rules, safety regulations and insurance has been examined in an extensive range of literature within the 'law and economics' tradition. Law and economics scholars have addressed the potential dangers (and benefits) of financial caps, and economists have also addressed optimal enforcement strategies in cases of oil spills. All these issues are also relevant for restoration orders, considering that the insolvent polluter will not afford either monetary compensation or restoration costs. Therefore, mandatory solvency guaranteed should complement restoration orders as well under this imperfect scenario.

However, the first limit of insurance for environmental harm is incomplete knowledge of hazardous events. Particularly, nature and magnitude of pollution events are beyond forecasting abilities. The second limit is reluctance to make insurance against events with a low probability of occurrence, even if insurance would be available and the magnitude of the event might be significant. Yet, if an event can be anticipated with a reasonable degree of probability that should be enough in order to establish insurance, otherwise liability for events with extremely high damages would be useless.

As to the costs to stop the harm and prevent further damage (see par. 3), the insurer would hold a strong interest in that activities to prevent additional damage are carried out immediately, so that the other heads of damages do not increase (*e.g.,* for the damage itself). For this reason, it would make sense to include them in the insurance coverage. Then, in order to avoid confusion with the costs of damage itself, insurance contracts should include a clear definition of the costs to prevent additional harm[85] after the accident occurred (and how to distinguish them from other heads of damages[86]).

In order to provide the adequate incentive, polluters should be liable for the share of extra-harm to the environment caused by lack of immediate action after knowing about it.

11 Costs of assessment

The last issue to consider in view of minimizing the social costs of environmental accidents through efficient remedies concern the costs of assessment (either for damages or restoration). This paragraph wants to shed a brighter light upon the reasons why costs of restoration may be higher than what expected, hence raising an additional issue to tackle when comparing the efficiency of remedies.

11.1 Restoration

The appropriate scale of restoration action can be determined only at the end of a process of damage assessment whose outcome strongly relies on the options technically available to restore

[84] Bocken.

[85] On the view that the obligation of the insurer may not extend to the preventive costs related to the main accident, see Candian, Responsabilità civile e assicurazione, Milano, 1993.

[86] For a review of cases, see Manuelli, *op. cit.*. Many costs of remediation may be indeed viewed as costs to prevent further damage if one just thinks that clean-up activities also help stop pollution.

natural resource[87]. Moreover, restoration might regard all components of a system or have more limited recovery goals[88].

The first phase[89] of environmental damage assessment aims at estimating the scale and significance of environmental damage by measuring the impact of the accident over ecological and human services that were previously provided by the damaged environment. After that, it is possible to determine whether the scale of damage should be regarded as significant or not. Liability laws normally establish these criteria. They normally differ from the existing environmental standards regulating pollution limits. In fact, it has been argued that many of these standards are only based on public health rather than ecological functions[90]. More adequate criteria of significance include the magnitude of the impact, duration, reversibility and sensitivity of the impacted resources[91].

If at the end of the first phase of damage assessment the environmental damage has been valued as "significant", a restoration program needs to be implemented in order to restore the ecological integrity of the damaged site[92]. The decision of the program, which is a decision on the method and the target to achieve, depends on the characteristics of the environment, on one hand, and the technical options available, on the other hand. Basically, there are three main options for resource restoration: non-intervention, limited and full-scale restoration.

The *non-intervention* approach means that natural resources are left alone to restore naturally and pollutants to degrade without using chemicals. This solution is deemed to be adequate in case of very fragile or inaccessible sites that may suffer additional harm from machinery and physical disturbances. For instance, many woodlands may be further damaged by misguided restoration and they better restore themselves naturally. Non-intervention implies the lowest costs of restoration but higher costs of monitoring, given the length of the post damage period and, thus, high interim losses. Yet, the value of naturally recovered habitats in the end is likely to be higher compared to artificially recovered sites[93]. Moreover, non-intervention needs a public justification since omitted policies after environmental accidents risk to be unacceptable[94].

Limited intervention is restoration through the planting of grasses, trees and other species to allow natural recolonization. This is the preferable strategy in many cases of damage affecting particularly valuable ecosystems that can regain their original value through minimum restoration. Limited intervention requires higher costs of cleanup but it has a greater ecological advantage since the

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[87] A further subdivision should be made between in-kind *repair* and in-kind *replacement*. Repair directly addresses the harm and takes account of the uniqueness of natural resources. In this way, use, nonuse and intrinsic values can be compensated. If repair is not possible (e.g., in case of loss of biodiversity), the damaged environment can be replaced by comparable natural resources. Replacement value is relatively easy to measure but it is less accurate and it does not compensate lost unique resources. Peck (1989), pp. 283-284.

[88] This distinction was laid down by William R. Jordan III.

[89] This phase is in common with monetary sanctions.

[90] European Commission – Directorate-General Environment, Study on the Valuation and Restoration of Biodiversity Damage for the Purpose of Environmental Liability, Final Report by Macalister Elliott and Partners Ltd and the Economics for the Environment Consultancy Ltd, May 2001, p. 11.

[91] *Ibidem.* However, criteria listed in the Annex I to the EU Environmental Liability Directive only refer to the number and density of individuals in the area covered, their role in relation to the species or the habitat conservation, their capacity for propagation and the capacity of natural recovery without intervention. These has been regarded as measurable data which need to be complemented by equivalent information about the baseline.

[92] Restoration is actually the primary option of compensation for environmental liability in many legal systems. Here, we mainly refer to the U.S. and the E.U. legal framework for environmental damage.

[93] Study on the Valuation and Restoration of Biodiversity Damage for the Purpose of Environmental Liability, *op.cit.,* p. 32.

[94] *Ibidem.*

ecosystem after the time of natural recovery will regain its original conservation value. However, their disadvantage is that higher interim losses are implied due to the time needed for natural restoration.

Full-scale restoration is the most expensive solution. It is needed in case of severe disruption of ecological functions. It includes highly expensive activities: intensive removal of contaminants, replacement of soils, replantation of plants and reintroduction of species. Its employment is not so frequent and limited to simple habitats or river sections[95].

Based on the above, it is straightforward that each restoration option implies a different cost of intervention, implementation and monitoring.

Monitoring is also needed to ensure that restoration targets are met. However, monitoring costs have to be valued carefully by weighing the quality of the data obtained with the cost of the techniques employed.

To sum up, restoration costs include:

a) costs of assessing the scale (scope) and significance of environmental damage;
b) costs of intervention;
c) costs of monitoring and surveillance.

All these costs have to be then balanced with the expected benefits of each restoration option (likelihood of success, return to baseline conditions, further effects on public health)[96]. Liability laws normally list the criteria to carry out a cost benefit analysis of restoration options, but they neither say which criterium is more important than another nor they force the expert/judge to follow a certain order in the decision-making. The final estimation tends to be left to the discretion of the judge, who might lack enough competence to weigh these criteria. What the law however requires is to identify the most cost-effective alternative.

Cost-effectiveness may be used either to maximise the benefits of restoration or to minimize its costs[97]. If the restoration target has been predetermined, the best option is the one that achieves that target at the least cost (max benefit)[98]. If instead the restoration budget has been predetermined, the best option is the one that achieves the greatest level of restoration for the given budget (min cost)[99]. Considering that the funding arrangements of "competent authorities" are defined in advance together with policy goals, it can be expected that the cost-effectiveness analysis of restoration options is assessed within both constraints (spending the least money to achieve the restoration target). Additional costs may be required in order to pursue a certain degree of impartiality and scientific integrity during the assessment process, given its legal and financial consequences[100].

It is clear from the above that restoration orders are the outcome of a complex discretionary process that may end up in satisfying divergent citizen interest groups. One of the most prominent

[95] Study on the Valuation and Restoration of Biodiversity Damage for the Purpose of Environmental Liability, *op.cit.,* p. 28.

[96] The criteria to select restoration options are almost the same under the US Oil Pollution Act of 1990 and the EU Directive on Environmental Liability.

[97] Study on the Valuation and Restoration of Biodiversity Damage for the Purpose of Environmental Liability, *op.cit.,* p. 34.

[98] Under the US law, primary restoration targets are compulsory.

[99] Study on the Valuation and Restoration of Biodiversity Damage for the Purpose of Environmental Liability, *op.cit.,* p. 34.

[100] *Ibidem,* p. 22.

example of social conflicts regards wildlife and notably wolves[101]. In their paper, Goedeke and Rikoon show a similar confrontation of interests concerning the restoration of otters. Wildlife officials (Missouri Department of Conservation) banned the trapping of otters in 1937 drawing on scientific studies warning a critical reduction in the number of otters[102] due to the overexploitation of habitats. On the other hand, in the 1990s locals started complaining about otters as unwanted predators that were causing the disappearance of fish from family ponds. Finally, activists came out as spokespeople for various nonhuman actors, such as fish, otters and rivers. In other words, the goal of activists was not the mere conservation of otters but the restoration of dynamism within the ecosystem and cooperative interactions among humans, fish, and otters. Drawing on such divergent interest, the authors show how restoration outcomes strictly depend on the most successful group in restoration controversies[103]. As a consequence, it is highly unlikely that the polluter can predict in an accurate manner what he has to pay to restore the environment given the high level of uncertainty[104].

An additional factor which is likely to raise restoration costs is the private interest of public administrations. Clean-up activities are indeed often supervised by government agencies, rather by injurers alone. Agencies normally tend to emphasize restoration as the goal of clean-up. That means that clean-up costs are more likely to be socially excessive because and public administrations may end up in overstating damages in litigation[105]. To avoid that, it would be better to exclude the supervisory role of agencies on clean-up and to make polluters strictly liable for the remaining harm after clean-up[106]. However, if firms' assets are insufficient and firms invest too little in clean-up, public supervision of clean-up activities is needed.

Finally, it must be noted that liability laws often prohibit disproportionate restoration investments[107]. It is possible to infer from that that an economic valuation of natural resources is needed in order to select the most cost-effective restoration option. So, restoration might require a double investment in costs of restoration assessment *plus* the costs of economic valuation.

11.2 Monetary compensation

Monetary awards imply high costs of litigation because of the difficult choice among possible methods. Even if all economic valuation techniques rely on individual preferences, they mainly differ based on the groups whose preferences are estimated. Indeed, the first step to elicit economic values should be to *identify those who suffer* from the damage and then to calculate *by how much they suffered*. The victims of environmental harm typically consist of those who *use* the damaged

[101] For a review of literature on this point, see Goedeke T.L. and Rikoon S. (2008), p. 112. Moreover, the authors mention the debate over the value of restorative goals in the case of critical habitats as well as over restoring commercial fish stocks. These discussions reveal the contested nature of science, on one hand, and the crucial role of experts, on the other hand.

[102] In 1977 the species was listed as endangered in the state of Missouri and reclassified as rare in the 1980s.

[103] *Ibidem.* The authors provide

[104] Baker and Raskolnikov (2017) distinguish four sources of uncertainty[104], one caused by the vagueness and lack of precision of the law (*legal uncertainty*), one caused by factual errors in the application of clear laws (*factual uncertainty*), one related to unsure detection (*detection uncertainty*) and, lastly, one regarding tort damages whose magnitude relies on both harm and judicial discretion (*sanction uncertainty*). Apparently, lack of clarity of rules on resource restoration and judicial discretion in their application can determine both legal and sanction uncertainty.

[105] De Alessi and Staaf 1989, Schmidtchen 1993, Friehe 2009b, Zervogianni E., p. 526.

[106] Polinsky and Shavell (1992), p. 10.

[107] These words are used in the Annex II to the Environmental Liability Directive (art. 1.3.3. b).

natural resource *directly* (e.g., those who use a forest for recreational purposes) and those who *use* the resource *indirectly* (e.g., those who live downstream and benefit from watershed protection thanks to the upstream forest). In addition to them, it is important not to forget about those who don't use a certain natural resource, such as a forest, but still care about its *existence* for actual and future generations. These people can be equally regarded as injured parties even without using the damaged environment. All these values of natural resources have been classically put under the two main categories of *use and non-use* values, with the former including direct and indirect use values and the latter embracing existence, option and bequest values[108]. Use values can be measured through price-based techniques and revealed preferences techniques, such as travel costs and hedonic pricing (information from individual preferences in surrogate markets). Non-use values can be only measured through stated preferences techniques, such as contingent valuation and choice experiments (information from preferences expressed in hypothetical markets).

The legal and economic debate around existing valuation methods has basically revolved around two main issues: (1) the opportunity to include non-use values in the magnitude of liability and (2) the reliability and validity of contingent valuation (and choice experiments) to include this component in the total economic value of the environment[109].

The problem posed by non-use values concerns the objective difficulties of converting non-use values in monetary terms so that social preferences can be elicited. The reason for that relies in the fact that they relate to non-monetizable costs, such as moral elements or other values that don't have an exchange equivalent. Absent a market for trading non-use values, scholars have generally concluded that it is better to exclude them from compensation[110]. Some also argued that non-use values cannot even be deemed as economic values[111].

A counterargument to that might be that the omission of non-use values would bring to serious under-compensation for unique, rare, ecologically significant and culturally valuable natural resources[112]. However, even if one would argue in favour of including non-use values in environmental damage assessment, issues still remain around the appropriate methodology to measure them. The debate on the reliability and validity of contingent valuation has been extremely lively in the last decades. The main points of criticism have been: the use of willingness to pay (rather than actual payments as a measure of value), potential biases in expressing the WTP after the accidental fact (rather than before), the nature of hypothetical market prices created through the survey (rather than real transactions)[113]. For some scholars, CV surveys do not report economic values but more exactly feelings, attitudes and ethical values which are not economic measures of losses[114]. Therefore, the reliability of the method has been questioned by many scholars and further studies supported this lack of reliability showing gross variations in estimations through CV surveys. In the end, if the method is highly uncertain and it imposes excessive social and private costs, it would result both in economic inefficiency and injustice, especially if non-use values

[108] The utility gained for knowing that the environment is available for present and future generations.
[109] Bergkamp 2001, p. 339.
[110] *Ibidem.*
[111] Stewart 1995, cited in Bergkamp 2001, at footnote 366, p. 342.
[112] Stewart 1995, cited in Bergkamp 2001, at footnote 361, p. 341.
[113] For a detailed list of problems raised by CV, *ibidem,* p. 340-341.
[114] Hausman.

(option and existence values) are not agreeably a component of the total economic value of nature[115].

Given the controversies around the use of CV to assess environmental damages, the most followed way to assess environmental damages nowadays is to refer to market prices (where available) or restoration costs. This seems to be in line with the principles of law and economics according to which damage assessments should be conducted in such a way that:

a) low transaction costs (feasible method) are involved in litigation[116];

b) difficult-to-measure components of environmental harm are excluded from damage awards.

This is due to the fact that greater accuracy in litigation involves tertiary costs[117] and it is important to set the level of damages so that the increase in tertiary costs is outweighed by the benefits (avoided expected loss). Moreover, since the injurer takes decisions on care and activity *ex ante* (based on the "expected" losses), more accuracy *ex post* will not necessarily result in optimal incentives. In particular, (slightly) inaccurate assessments have to be considered efficient to the extent that losses are "on average" correct. Based on that, it would make sense to invest in accuracy in case of extremely large environmental accidents, whereas small accidents would be better assessed through methods that are accurate "on average".

In case of difficult-to-value damages, experts can help minimise information costs thanks to their superior knowledge[118]. Experts might even help the judge to achieve more accurate and independent assessments. Therefore, as a general principle it would make economic sense to have experts for extremely difficult damage assessments. Scholars also pointed out possible disadvantages in the use of experts, such as biases, possible "public choice" issues[119], inefficient games between the parties' experts[120] and conflicts of interests of party-appointed experts[121]. The U.S. (and European) doctrine of law and economics addressed all these issues and proposed a variety of legal mechanisms to control the quality of expert advice[122], like court-appointed experts, standardized ways of damage assessment, training for judges, peer-review[123] and statistical information[124]. In any case, it would be important that judges always verify the expert evidence on damage assessment. If cases are settled more than tried, then alternative mechanisms should be employed to control the evidence in the bargaining phase[125].

11.3 Comparing remedies

It is clear from the above that both remedies may imply considerable costs of assessment. Two scenarios may then occur:

- **R > M** (assessment costs of restoration > assessment costs of monetary sanction)

[115] Shavell in Hausman 1993, p. 371. According to Bergkamp, tools which differ from liability would be better suited to reflect nonuse values (Bergkamp 2001, p. 343).

[116] Kokott, Klaphake and Marr 2005.

[117] Calabresi 1977. Talking about transaction costs would instead be not exact since in accidental relationships there is no transaction occurring between injurers and victims.

[118] This is due to the specialization of the expert and the advantage of the repeated player (Galanter 1974).

[119] Parker 1995.

[120] Tomlin and Cooper 2008.

[121] See for full references Faure and Visscher 2011, p. 386ss.

[122] *Ibidem,* p. 388-395.

[123] Alemanno (2008.

[124] Meadow and Sunstein 2001.

[125] Faure and Visscher 2001, p. 396.

For instance, the costs to undertake restoration may be very high, while data to conduct economic valuations may be easily available. M seems thus to be preferred over R, as it would allow to minimise tertiary costs. However, it is important to understand whether M is close to the real magnitude of damage or not. In the former case, M would be more efficient. Conversely, if the magnitude of harm is very large and M is unlikely to internalise the full cost to the environment, then it would make economic sense to adopt R (and base liability on cleanup costs). Yet, as pointed out by Endres and Friehe (2015), liability based on clean-up costs would induce the injurer to adopt optimal care, while it would reduce the incentives of clean-up upon the victim. For this reason, it would make economic sense to base liability on clean-up costs (and opt for R), if the injurer's influence over social costs is more important. That would allow to achieve optimal deterrence and restoration of the impaired environment. Conversely, if the policy maker also cares of victim's precaution, a fixed liability regime based on both harm and clean-up costs should be preferred.

- **M > R** (assessment costs of monetary sanction > assessment costs of restoration)
  For instance, the economic valuation is highly time-consuming and data-demanding. R seems thus to be preferred over M, as it would allow to minimise tertiary costs. Also, in this case, it would make sense to opt for liability based on harm plus actual clean-up costs if one wants to achieve socially optimal levels of injurer's care, whereas the fixed liability regime works better if one wants to achieve socially optimal levels of victim's care.